



TETRA TECH, INC.

TECHNICAL MEMORANDUM

Basewide Groundwater Monitoring Program Report
Winter 2005
Installation Restoration Program Site 20, Area 1
Vandenberg Air Force Base, California

17 June 2005

Prepared by:
Tetra Tech, Inc.
4213 State Street, Suite 100
Santa Barbara, CA 93101

1.0 INTRODUCTION

This report documents the activities and results of the winter 2005 groundwater monitoring at Installation Restoration Program Site 20, Area 1 (Underground Storage Tank [UST] Area), Operable Unit 1, Vandenberg Air Force Base, Santa Barbara County, California. Tetra Tech, Inc. (Tetra Tech) collected groundwater samples at Site 20, Area 1 during February 2005. The location of Site 20 is shown on Figure 1.

The groundwater monitoring is being completed in accordance with the Basewide Groundwater Monitoring Program (BGMP) Work Plan (U.S. Air Force 2000a), the BGMP Health and Safety Plan Addendum (U.S. Air Force 2000b), the Basewide Sampling and Analysis Plan (U.S. Air Force 2003), the BGMP Quality Assurance Project Plan (QAPP) Addendum (U.S. Air Force 2004), Vandenberg AFB Hazardous Waste Management Plan (U.S. Air Force 2002), and the Waste Management Plan Addendum (U.S. Air Force 2005). Regulatory oversight of the work is being performed by the California Department of Toxic Substances Control (DTSC) and Regional Water Quality Control Board—Central Coast Region (RWQCB).

Site background information is summarized in Section 2.0. The scope of work and methodology for sampling are presented in Section 3.0. The results of the groundwater monitoring are presented in Section 4.0. Quality Assurance/Quality Control (QA/QC) is discussed in Section 5.0. Recommendations for future sampling rounds are presented in Section 6.0.

2.0 BACKGROUND

2.1 SITE DESCRIPTION

Site 20, Area 1 (UST Area) is located in the main cantonment area, on the west side of Utah Avenue (Figure 1). Site 20 also includes Landfill 1 (Area 2) and Drum Disposal Site 1 (Area 3), which are discussed separately in this report due to the differences in hydrogeology, chemicals of concern, and sampling program. Site 20, Area 1 groundwater monitoring is performed semiannually, during winter and summer quarters. Site 20, Areas 2 and 3 is sampled annually, with the exception of well 20-MW-3, which is sampled semiannually.

Area 1 is located in the northern portion of Site 20. Three 10,000-gallon, concrete USTs were removed from Area 1 in 1993. The USTs were used to store diesel fuel from 1942 until 1946 and gasoline from 1951 to 1953. The USTs were apparently not used after 1953. Total petroleum hydrocarbons quantified as both diesel and gasoline; benzene, toluene, ethylbenzene, and xylene (BTEX) compounds; 1,2-dichloroethane (DCA); and 1,2-dibromoethane (EDB) have been detected in groundwater samples from Area 1. A complete description of Area 1 can be found in the draft *Site 20 Underground Storage Tank Site Assessment Report* (Jacobs Engineering Group [JEG] 1997).

In 1998, a source reduction system (SRS) was installed to remove petroleum hydrocarbons from the soil and groundwater near the former UST locations (Montgomery Watson Harza [MWH 2001]). JEG operated this system from August 1998 to June 1999. The system was offline between June 1999 and January 2001; it has been operated by MWH since January 2001. The system consists of a dual-phase extraction system in well 11669-EW-1, which is located between monitoring wells 11669-MW-4 and 11669-MW-5 (Figure 1). The SRS operations were transitioned to Shaw Environmental, Inc. (Shaw) in September 2004 and are ongoing. Additional information on the extraction system operations can be obtained by contacting 30 CES/CEVR or MWH.

2.2 HYDROGEOLOGY

Groundwater levels measured in January 2005 with the extraction system in operation indicate that groundwater elevations ranged from approximately 406 feet above mean sea level (msl) to 419 feet above msl (Table 1). During winter 2005, the interpreted direction of groundwater flow at Site 20, Area 1 was to the northeast with an average hydraulic gradient of 0.03 feet per foot. The gradient has been influenced by operation of extraction well 11669-EW-1. The extraction well radius of influence is approximated in the groundwater elevation contour map (Figure 1). Groundwater monitoring well 11669-MW-4, which is upgradient of the extraction well, appears to be outside of this radius of influence. Downslope and downgradient from Storage Road, groundwater is discharging to the surface at seeps Area 1-SP-1 and Area 1-SP-2 at approximately 403 feet above msl.

3.0 SCOPE OF WORK

The work performed during winter 2005 at Site 20, Area 1 included measuring groundwater levels, collecting groundwater and surface water samples for laboratory analysis, and preparing this report.

3.1 GROUNDWATER MONITORING METHODOLOGY

Six monitoring wells were sampled at Site 20, Area 1 during winter 2005. A MicroPurge pump and Grundfos pumps were used for purging groundwater at wells 11669-MW-2 and 11669-MW-4 through 11669-MW-8. Sampling was conducted in accordance with the documents cited in Section 1.0. Measured groundwater elevations are presented in Table 1 and groundwater contours are illustrated on Figure 1. Purge records are provided in Appendix A.

In general, wells were purged until a minimum of one pump and tubing volume of water (for MicroPurge pumps) or three well volumes of water (for Grundfos pumps) were removed and water quality parameters had stabilized. Criteria for determining stabilization are three successive measurements of temperature within ± 0.1 degree Celsius, pH within ± 0.1 , conductivity within ± 5 percent, and a turbidity reading of less than 5 nephelometric turbidity units (NTUs). In cases where stability or a turbidity reading of less than 5 NTUs was not obtained, samples were collected after purging a minimum of five pump and tubing volumes of water (for MicroPurge pumps) or five well volumes of water (for Grundfos pumps).

3.1.1 MicroPurge Groundwater Sampling

MicroPurge sampling was conducted at monitoring well 11669-MW-2. The pumping rate was determined prior to sampling and calibrated to maintain a static water level (i.e., no drawdown).

3.1.2 Standard Groundwater Sampling

A 2-inch Grundfos pump was used for purging groundwater at monitoring wells 11669-MW-4 through 11669-MW-8. All of these wells were purged dry and sampled after sufficient recharge using a disposable Teflon bailer.

3.2 SURFACE WATER SAMPLING

Tetra Tech inspected the two surface seep locations at Area 1 that are accessible (Area1-SP-1, and Area1-SP-2) and surveyed the site for the presence of surface water. Both seep locations were sampled with as little disturbance to the water as possible. Sampling from the surface ensures that the analytical chemistry resembles that to which potential human and ecological receptors could be exposed.

4.0 RESULTS

Temperature, conductivity, pH, and turbidity were measured in the field during purging. These measurements are presented in Appendix A. Readings taken immediately prior to sampling are presented in Table 2. Fixed laboratory analyses were performed by EMAX Laboratories, Inc. in Torrance, California. Samples were analyzed according to the BGMP Work Plan (U.S. Air Force 2000a) for volatile organic compounds (VOCs) by U.S. Environmental Protection Agency (EPA) method SW8260B, and for total petroleum hydrocarbons as gasoline (TPHg) and total petroleum hydrocarbons as diesel (TPHd) by EPA method SW8015B. Laboratory analyses and data validation were conducted according to the BGMP QAPP Addendum (U.S. Air Force 2004). Data validation was performed on 100 percent of the analytical data. Analytical results are presented in Tables 3 and 4 and on Figure 2. Historical data for key contaminants of concern are presented in Table 5 and on Figures 3A and 3B. Figure 3A contains historical data for key COCs from October 1998 through fall 2003, and Figure 3B contains historical data for key COCs from winter 2004 to present. Chain-of-custody records are provided in Appendix B.

4.1 VOLATILE ORGANIC COMPOUNDS

Groundwater samples collected from the six wells and two surface water locations sampled at Site 20, Area 1 were analyzed for VOCs. VOCs were detected in four of these wells (Table 3). No VOCs were detected in the surface water samples from Area1-SP-1 and Area1-SP-2.

Benzene was detected above the primary maximum contaminant level (MCL) of 1 µg/L in groundwater from wells 11669-MW-4 and 11669-MW-5, at concentrations of 3.7 µg/L (3.2 µg/L in the duplicate sample) and 64 µg/L, respectively. The compound 1,2-dichloroethane (1,2-DCA) was detected above the primary MCL of 0.5 µg/L in groundwater from wells 11669-MW-2 and 11669-MW-5, at concentrations of 9.9 and 26 µg/L, respectively.

Concentrations of benzene were within the range of those previously detected at well 11669-MW-4 (Table 5). Benzene concentrations at well 11669-MW-5 have been decreasing steadily since October 1998, when a concentration of 4,520 µg/L was detected. Concentrations of 1,2-DCA were within the ranges of those previously detected in groundwater from wells 11669-MW-2 and 11669-MW-4, and steadily decreased since October 1998 at well 11669-MW-5. Concentrations of EDB in groundwater from well 11669-MW-5 have consistently decreased since summer 2000.

4.2 TOTAL PETROLEUM HYDROCARBONS

Groundwater samples collected from the six wells and two surface water locations sampled at Site 20, Area 1 were analyzed for TPHg. TPHg were detected in groundwater from wells 11669-MW-4 and 11669-MW-5, at concentrations of 0.22 mg/L (0.26 mg/L in the duplicate sample) and 0.42 mg/L, respectively (Table 4). The TPHg concentration in groundwater from well 11669-MW-4 was within the range of those detected in previous quarters, while the TPHg concentration in groundwater from well 11669-MW-5 decreased and has been decreasing steadily since October 1998 (Table 5).

In response to comments on the winter 2004 report, TPHd has been added as a key COC at Site 20, Area 1 to the historical COC table (Table 5) and historical figures (Figures 3A and 3B). Groundwater samples collected from wells 11669-MW-2, 11669-MW-5, and 11669-MW-6 were analyzed for TPHd; TPHd were not detected.

5.0 QUALITY ASSURANCE/QUALITY CONTROL

All of the analytical data presented in this report were validated according to the Vandenberg QAPP Addendum (U.S. Air Force 2004). The data validation process included a review of sample preservation, temperature, and hold times; detection and quantitation limits; instrument calibration; and equipment blank, trip blank, method blank, laboratory control sample, and matrix spike/matrix spike duplicate. Data validation qualifiers and comments are provided on the data tables to indicate the results of the data validation and to quantitatively indicate the usability of the data. In addition, field sampling records are reviewed to assess the potential for any field conditions to adversely impact the data quality.

There were no significant quality assurance/quality control discrepancies with the data presented in this report. The data quality objectives for the winter 2005 sampling at Site 20, Area 1 were achieved.

6.0 RECOMMENDATIONS

The summer 2005 sampling will be conducted according to the work plan (U.S. Air Force 2000a).

7.0 REFERENCES

Jacobs Engineering Group, Inc. (JEG)

1997 *Site 20 Underground Storage Tank Assessment Report*. September.

Montgomery Watson Harza (MWH)

2001 *Performance Monitoring Report, Site 20 Source Reduction System*. Vandenberg Air Force Base, California. October.

U.S. Air Force

2000a *Basewide Groundwater Monitoring Program Work Plan*. Prepared for 30 CES/CEV, Installation Restoration Program, Vandenberg Air Force Base, California, and Headquarters Air Force Space Command, Peterson Air Force Base, Colorado. Prepared by Tetra Tech, Inc. December.

U.S. Air Force

2000b *Basewide Groundwater Monitoring Program Health and Safety Plan Addendum*. Prepared for 30 CES/CEV, Installation Restoration Program, Vandenberg Air Force Base, California, and Headquarters Air Force Space Command, Peterson Air Force Base, Colorado. Prepared by Tetra Tech, Inc. December.

U.S. Air Force

2002 *Headquarters Thirtieth Space Wing, Vandenberg AFB, California. Hazardous Waste Management Plan, 30 SW Plan 32-7043-A, Change 1*. HQ 30th Space Wing, Vandenberg Air Force Base, California 93437-6261. April.

U.S. Air Force

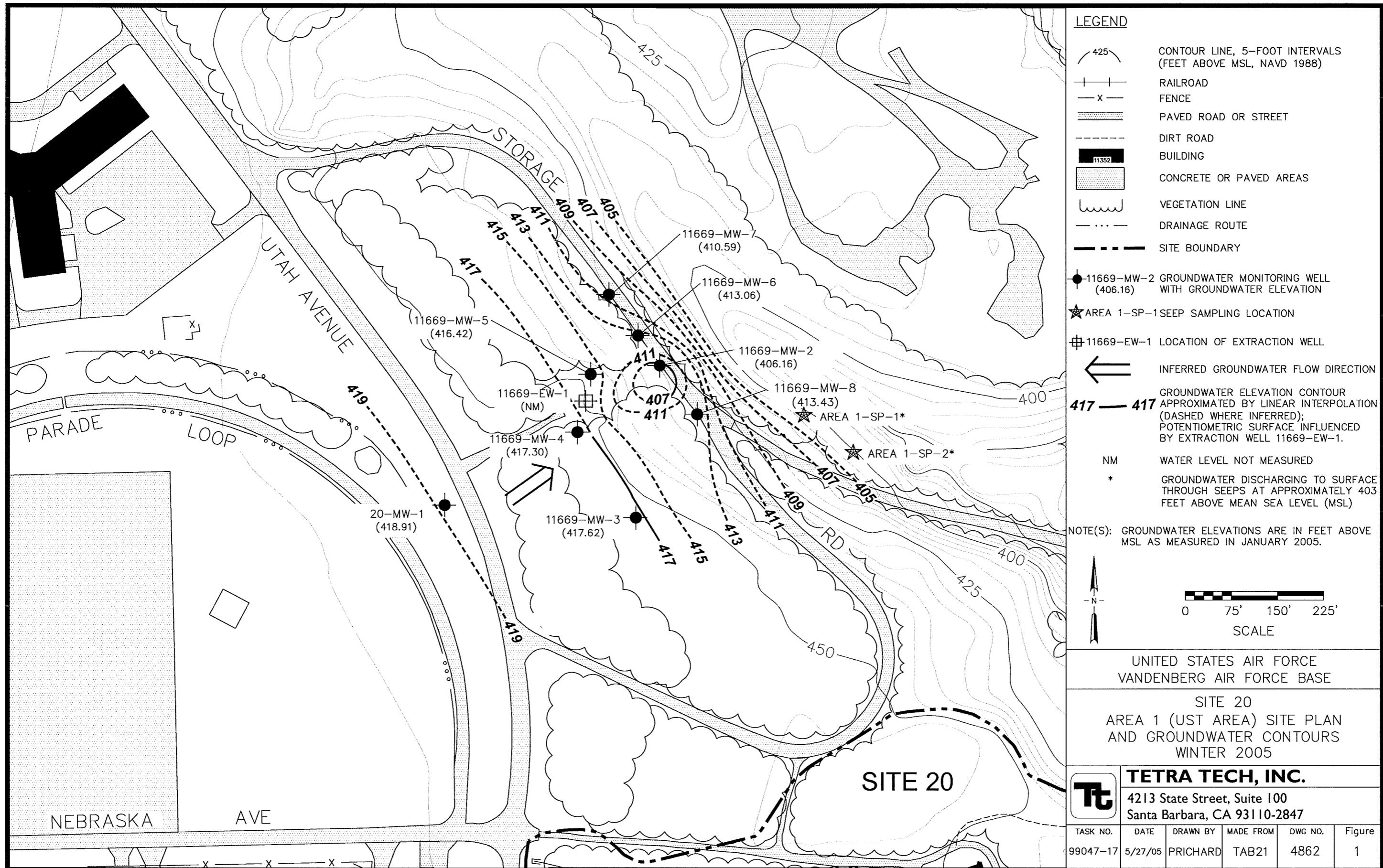
2003 *Basewide Sampling and Analysis Plan. Final*. Prepared for 30 CES/CEV Installation Restoration Program, Vandenberg Air Force Base, California, and Headquarters Air Force Space Command, Peterson Air Force Base, Colorado. Prepared by Tetra Tech, Inc. September.

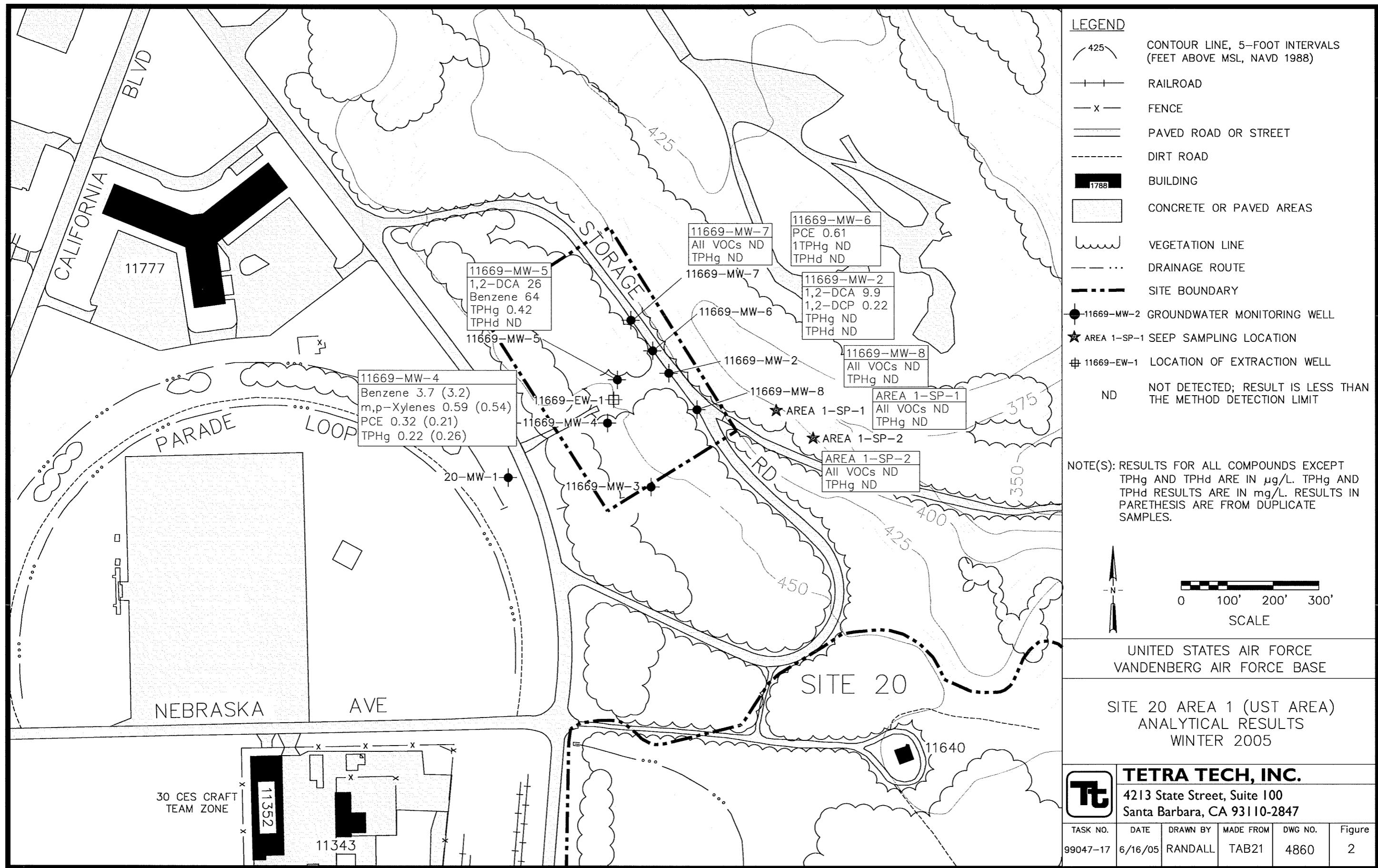
U.S. Air Force

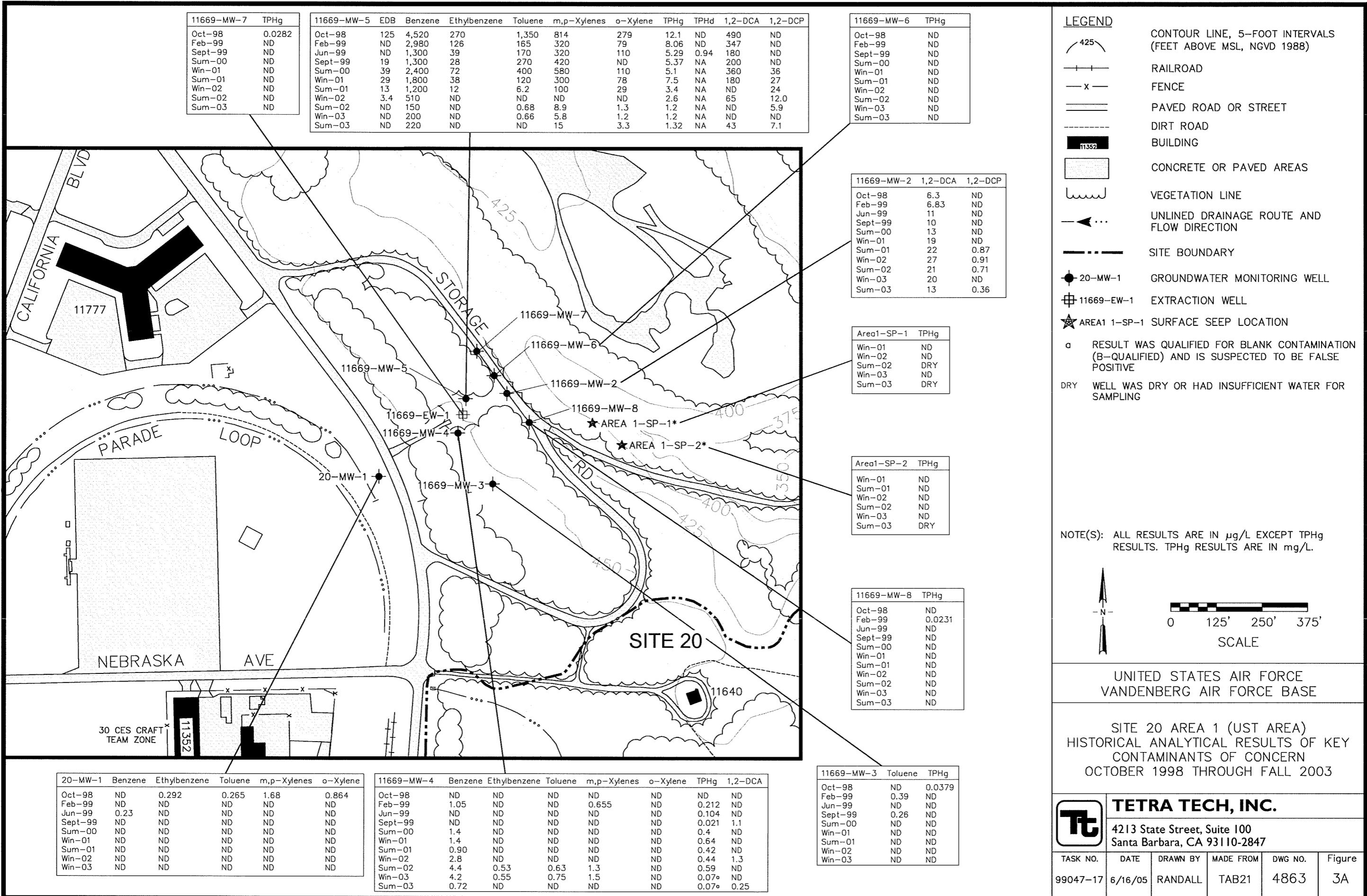
2004 *Basewide Groundwater Monitoring Program Quality Assurance Project Plan Addendum. Final*. Prepared for Department of the Air Force 30 CES/CEVR, 806 13th Street, Suite 116, Vandenberg Air Force Base, California and Department of the Air Force, Air Force Center for Environmental Excellence, DERA Restoration Division, 3300 Sidney Brooks, Brooks City-Base, Texas. Prepared by Tetra Tech, Inc. July.

U.S. Air Force

2005 *Waste Management Plan Addendum. Final*. 730 CES/CEVR, IRP, Vandenberg Air Force Base, California, and Headquarters Air Force Space Command, Peterson Air Force Base, Colorado. Prepared by Tetra Tech, Inc. February.







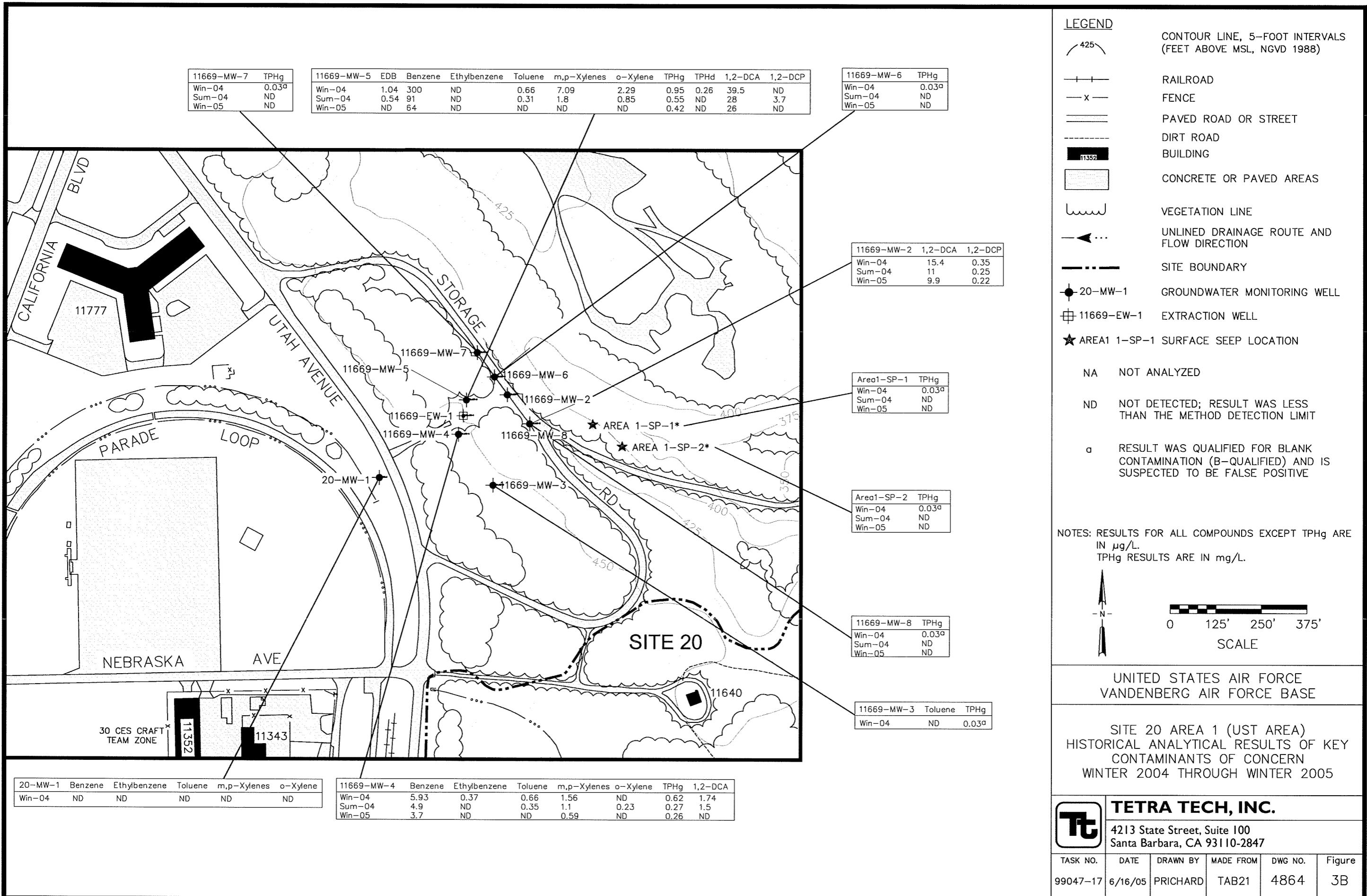


Table 1
Groundwater Elevations
IRP Site 20, Area 1 (UST Area)
Vandenberg AFB, California

Monitoring Well	Top of Casing Elevation (feet above msl)	Date Measured	Groundwater Depth (feet below TOC)		Groundwater Elevation (feet above msl)			
			Winter 2005	Winter 2005	Winter 2005	Summer 2004	Winter 2004	Summer 2003 ^a
20-MW-1	459.01	27-Jan-05	40.10		418.91	419.23	419.37	419.88
11669-EW-1	451.27	NM	NM		NM	NM	NM	NM
11669-MW-2	430.73	27-Jan-05	24.57		406.16	406.56	406.80	406.54
11669-MW-3	456.02	27-Jan-05	38.40		417.62	417.88	417.54	418.6
11669-MW-4	453.40	27-Jan-05	36.10		417.30	417.48	417.62	418.43
11669-MW-5	445.94	27-Jan-05	29.52		416.42	416.55	406.42	417.45
11669-MW-6	430.98	27-Jan-05	17.92		413.06	413.20	413.53	413.95
11669-MW-7	433.18	27-Jan-05	22.59		410.59	410.27	NM	411.40
11669-MW-8	430.01	27-Jan-05	16.58		413.43	413.19	413.38	413.72

Definitions:

- msl
- mean sea level
- NM
- not measured
- TOC
- top of well casing

Notes:

- ^a - Water levels were measured while the extraction system was off.

Table 2
Water Quality Parameters
Winter 2005
IRP Site 20, Area 1 (UST Area)
Vandenberg AFB, California

Sampling Location	11669-MW-2	11669-MW-4	11669-MW-5	11669-MW-6	11669-MW-7	11669-MW-8	Area1-SP-1	Area1-SP-2
Sample ID	V11669MW2	V11669MW4	V11669MW5	V11669MW6	V11669MW7	V11669MW8	VArea1SP1	VArea1SP2
Collection Date	25-Feb-05							
Field Parameters¹:								
Temperature (° Celsius)	16.58	17.05	16.63	17.12	17.04	16.05	NM	NM
Conductivity (µmhos/cm)	1,956	8,180	2,992	1,724	2,029	1,570	NM	NM
pH	5.25	5.31	5.74	5.42	5.17	5.43	NM	NM
Turbidity (NTUs)	3.86	2.84	53.1	4.54	99.9	14.0	NM	NM

Definition(s):

µmhos/cm - micromhos per centimeter

NTU - nephelometric turbidity unit

Note(s):

- 1 - Field parameters measured immediately prior to sampling.

Table 3
VOCs in Groundwater and Surface Water
Winter 2005
EPA Method SW8260B (µg/L)
IRP Site 20, Area 1 (UST Area)
Vandenberg AFB, California

Sample Location	11669-MW-2	11669-MW-4	11669-MW-5	11669-MW-6	11669-MW-7	11669-MW-8	Areal-SP-1	Areal-SP-2
Sample ID	V11669MW2	V11669MW4	V11669MW5 (D)	V11669MW6	V11669MW7	V11669MW8	VArea1SP1	VArea1SP2
Collection Date	25-Feb-05	25-Feb-05	25-Feb-05	25-Feb-05	25-Feb-05	25-Feb-05	25-Feb-05	25-Feb-05
Primary								
MDL ^a	PQL ^a	MCL						
1,2-DCA	0.06	1.0	0.5	9.9	g	0.2 U g	0.2 U g	0.2 U g
1,2-DCP	0.25	0.5	5	0.22	J q	0.2 U g	0.2 U g	0.2 U g
Benzene	0.07	0.4	1	0.2	U g	3.7	g	0.2 U g
m,p-Xylenes	0.25	2.0	1,750 ^b	0.5	U g	0.59	J q	0.5 U g
PCE	0.15	1.0	5	0.2	U g	0.32	J q	0.2 U g
All other analytes	N/A	N/A	N/A	ND	ND	ND	ND	ND

Data Validity Qualifier(s):

- J - The analyte was positively identified and the result is usable; however, the analyte concentration is an estimated value.
- U - The analyte was not detected at or above the MDL.

Data Validity Comment(s):

- g - The data met prescribed criteria as detailed in the QAPP.
- q - The analyte detection was below the PQL.

Definition(s):

- (D) - duplicate sample
- DCA - dichloroethane
- DCP - dichloropropane
- MCL - maximum contaminant level
- MDL - method detection limit
- µg/L - micrograms per liter
- N/A - not applicable
- ND - not detected; result is less than the MDL.
- PCE - tetrachloroethene
- PQL - practical quantitation limit
- QAPP - Quality Assurance Project Plan

Note(s):

Bold type indicates results that were above the MCL.

^a - Values from QAPP Addendum (U.S. Air Force 2004).

^b - MCL of 1,750 µg/L applies to the sum of m-xylene, o-xylene, and p-xylene.

Table 4
TPH in Groundwater and Surface Water
Winter 2005
EPA Method SW8015B (mg/L)
IRP Site 20, Area 1 (UST Area)
Vandenberg AFB, California

Sample Location	Sample ID	Collection Date	TPH as Gasoline			TPH as Diesel		
			MDL¹	0.02		PQL¹	0.1	
11669-MW-2	V11669MW2	25-Feb-05	0.02	U	g	0.094	U	g
11669-MW-4	V11669MW4	25-Feb-05	0.22		g		NA	
11669-MW-4	V99W502 (D)	25-Feb-05	0.26		g		NA	
11669-MW-5	V11669MW5	25-Feb-05	0.42		g	0.094	U	g
11669-MW-6	V11669MW6	25-Feb-05	0.02	U	g	0.095	U	g
11669-MW-7	V11669MW7	25-Feb-05	0.02	U	g		NA	
11669-MW-8	V11669MW8	25-Feb-05	0.02	U	g		NA	
Area1-SP-1	VArea1SP1	25-Feb-05	0.02	U	g		NA	
Area1-SP-2	VArea1SP2	25-Feb-05	0.02	U	g		NA	

Data Validity Qualifier(s):

- U - The analyte was not detected at or above the MDL.

Data Validity Comment(s):

- g - The data met prescribed criteria as detailed in the QAPP.

Definition(s):

- (D) - duplicate sample
- MDL - method detection limit
- mg/L - milligrams per liter
- NA - not analyzed
- PQL - practical quantitation limit
- QAPP - Quality Assurance Project Plan
- TPH - total petroleum hydrocarbons

Note(s):

- 1 - Values from QAPP Addendum (U.S. Air Force 2004).

Table 5
Summary of Key Contaminants of Concern
IRP Site 20, Area 1 (UST Area)
Vandenberg AFB, California

	EDB (µg/L) ^a												Ethylbenzene (µg/L) ^b														
	Oct-98	Feb-99	Jun-99	Sept-99	Sum-00	Win-01	Sum-01	Win-02	Sum-02	Win-03	Sum-03	Win-04	Sum-04	Win-05	Oct-98	Feb-99	Jun-99	Sept-99	Sum-00	Win-01	Sum-01	Win-02	Sum-02	Win-03	Sum-03	Win-04	Sum-04
20-MW-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	NA	ND	NA	ND	ND	ND	ND	ND	NA	ND	NA	ND	ND	NA	NA	
11669-MW-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
11669-MW-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	NA	ND	NA	ND	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	NA	
11669-MW-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
11669-MW-5	125	ND	ND	19	39	29	13	3.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
11669-MW-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
11669-MW-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
11669-MW-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Areal-SP-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Areal-SP-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	

Table 5
Summary of Key Contaminants of Concern
IRP Site 20, Area 1 (UST Area)
Vandenberg AFB, California

	m,p-Xylene (µg/L) ^c												TPHg (mg/L)														
	Oct-98	Feb-99	Jun-99	Sept-99	Sum-00	Win-01	Sum-01	Win-02	Sum-02	Win-03	Sum-03	Win-04	Sum-04	Win-05	Oct-98	Feb-99	Jun-99	Sept-99	Sum-00	Win-01	Sum-01	Win-02	Sum-02	Win-03	Sum-03	Win-04	Sum-04
20-MW-1	1.68	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	
11669-MW-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
11669-MW-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	NA	ND	NA	ND	ND	NA	ND	NA	ND	NA	NA	NA	NA	NA	NA	
11669-MW-4	ND	0.655	ND	ND	ND	ND	ND	ND	ND	ND	1.3	1.5	ND	1.56	1.1	0.59											
11669-MW-5	814	320	320	420	580	300	100	ND	8.9	5.8	15	7.09	1.8	ND													
11669-MW-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
11669-MW-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
11669-MW-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Area1-SP-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Area1-SP-2	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	

Table 5
Summary of Key Contaminants of Concern
IRP Site 20, Area 1 (UST Area)
Vandenberg AFB, California

	TPHD (mg/L)												1,2-DCP (µg/L) ^e														
	Oct-98	Feb-99	Jun-99	Sept-99	Sum-00	Win-01	Sum-01	Win-02	Sum-02	Win-03	Sum-03	Win-04	Sum-04	Win-05	Oct-98	Feb-99	Jun-99	Sept-99	Sum-00	Win-01	Sum-01	Win-02	Sum-02	Win-03	Sum-03	Win-04	Sum-04
20-MW-1	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA		
11669-MW-2	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
11669-MW-3	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
11669-MW-4	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
11669-MW-5	ND	ND	0.94	1.4	NA	NA	0.26	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND										
11669-MW-6	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
11669-MW-7	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
11669-MW-8	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Area1-SP-1	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Area1-SP-2	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		

Table 5
Summary of Key Contaminants of Concern
IRP Site 20, Area 1 (UST Area)
Vandenberg AFB, California

	Benzene ($\mu\text{g/L}$) ^f												Toluene ($\mu\text{g/L}$) ^g														
	Oct-98	Feb-99	Jun-99	Sept-99	Sum-00	Win-01	Sum-01	Win-02	Sum-02	Win-03	Sum-03	Win-04	Sum-04	Win-05	Oct-98	Feb-99	Jun-99	Sept-99	Sum-00	Win-01	Sum-01	Win-02	Sum-02	Win-03	Sum-03	Win-04	Sum-04
20-MW-1	ND	ND	0.23	ND	ND	ND	ND	ND	NA	ND	NA	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
11669-MW-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
11669-MW-3	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	NA	
11669-MW-4	ND	1.05	ND	ND	ND	1.4	1.4	0.90	2.8	4.2	4.2	0.72	5.93	4.9	3.7												
11669-MW-5	4,520	2,980	1,300	1,300	2,400	1,800	1,200	510	200	200	200	220	300	91	64												
11669-MW-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
11669-MW-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
11669-MW-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Areal-SP-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Areal-SP-2	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	

Table 5
Summary of Key Contaminants of Concern
IRP Site 20, Area 1 (UST Area)
Vandenberg AFB, California

o-Xylene (µg/L) ^b												1,2-DCA (µg/L) ⁱ															
	Oct-98	Feb-99	Jun-99	Sept-99	Sum-00	Win-01	Sum-02	Win-02	Sum-03	Win-03	Sum-04	Win-04	Sum-05		Oct-98	Feb-99	Jun-99	Sept-99	Sum-00	Win-01	Sum-02	Win-02	Sum-03	Win-03	Sum-04	Win-04	Sum-05
20-MW-1	0.864	ND	ND	ND	ND	ND	ND	ND	NA	ND	NA	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA			
11669-MW-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			
11669-MW-3	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	NA			
11669-MW-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			
11669-MW-5	279	79	110	ND	110	78	29	ND	1.3	1.2	3.3	2.29	0.85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			
11669-MW-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			
11669-MW-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			
11669-MW-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			
Areal-SP-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
Areal-SP-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			

Table 5
Summary of Key Contaminants of Concern
IRP Site 20, Area 1 (UST Area)
Vandenberg AFB, California

Definition(s):	
DCA	- dichloroethane
DCP	- dichloropropane
EDB	- 1,2-dibromoethane (ethylene dibromide)
MCL	- maximum contaminant level
$\mu\text{g/L}$	- micrograms per liter
mg/L	- milligrams per liter
NA	- not analyzed
ND	- not detected; result is less than the MDL.
TPH ^g	- total petroleum hydrocarbons as gasoline

Note(s):	
	Bold type indicates results that were above the MCL.
a	- The MCL for 1,2-EDB is 0.05 $\mu\text{g/L}$.
b	- The MCL for ethylbenzene is 300 $\mu\text{g/L}$.
c	- The MCL for the sum of m-xylene, o-xylene, and p-xylene is 1,750 $\mu\text{g/L}$.
d	- The data were qualified for blank contamination during the validation process. The laboratory method blank result showed the same order of magnitude as the sample result, which is considered not to have originated from the environmental sample, due to possible cross-contamination. The result is strongly suspected to be false positive.
e	- The MCL for 1,2-DCP is 5 $\mu\text{g/L}$.
f	- The MCL for benzene is 1 $\mu\text{g/L}$.
g	- The MCL for toluene is 150 $\mu\text{g/L}$.
h	- The MCL for the sum of m-xylene, o-xylene, and p-xylene is 1,750 $\mu\text{g/L}$.
i	- The MCL for 1,2-DCA is 0.5 $\mu\text{g/L}$.

APPENDIX A

PURGE RECORDS



TETRA TECH, INC.
4213 State Street STE 100
Santa Barbara, CA 93110
Telephone (805) 681-3100
Telefax (805) 681-3108

GROUNDWATER MONITORING WELL

FIELD DATA LOG SHEET - PURGING

Page 1 of 1

DATE 2/25/05

PROGRAM NAME B6m8

SITE NUMBER 20 A1

PURGING DEVICE 2" SUBMERSIBLE GRUNDFOS PUMP

MONITORING WELL IDENTIFICATION 11669-MW-6

DUPPLICATE ID. -

SAMPLING DEVICE DISPOSABLE TEFTON BAILER

MONITORING WELL LEVEL (ft btoc) 11.669 MW-6

TOTAL WELL DEPTH (ft btoc) 30.2

PID READING IN CASING (ppm) ND

DUPLICATE ID. -

(initial) ND (vented to)

STATIC WATER LEVEL (ft btoc) 17.87

CASING DIAMETER (in) 4

PID READING IN BREATHING ZONE (ppm) ND

(initial) ND (vented to)

WATER COLUMN (feet) 12.31

WELL VOLUME (V) (gals) 8.00

3 V (gals) 24.0

SAMPLER'S SIGNATURE

WELL VOLUME (V) (gals)

WATER LEVEL (ft btoc) 17.89

Pump Depth (ft btoc) 30

EC (µmhos/cm) 15.53

Temp (Deg. C) 16.49

pH 5.43

Turbidity (NTU) 15.2

Dissolved Oxygen (mg/L) 4.09

ORP (mV) 2350

Color clear

WATER LEVEL (ft btoc) 17.98

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.47

Temp (Deg. C) 16.43

pH 5.46

Turbidity (NTU) 6.09

Dissolved Oxygen (mg/L) 3.62

ORP (mV) 2593

Color clear

WATER LEVEL (ft btoc) 17.79

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.96

Dissolved Oxygen (mg/L) 3.49

ORP (mV) 250.0

Color clear

WATER LEVEL (ft btoc) 17.14

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.96

Temp (Deg. C) 16.96

pH 5.47

Turbidity (NTU) 3.22

Dissolved Oxygen (mg/L) 3.21

ORP (mV) 2486

Color clear

WATER LEVEL (ft btoc) 17.24

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.42

Temp (Deg. C) 16.42

pH 4.54

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05

Pump Depth (ft btoc) 30

EC (µmhos/cm) 16.41

Temp (Deg. C) 16.41

pH 5.41

Turbidity (NTU) 3.04

Dissolved Oxygen (mg/L) 219.5

ORP (mV) 219.5

Color clear

WATER LEVEL (ft btoc) 17.05



TETRA TECH, INC.
4213 State Street STE 100
Santa Barbara, CA 93110
Telephone (805) 581-3100
Telefax (805) 681-3108

GROUNDWATER MONITORING WELL FIELD DATA LOG SHEET - PURGING

Page 1 of 1

20A1

DATE 2/25/05 SITE NUMBER 8571P

PROGRAM NAME 1669-MW-88

MONITORING WELL IDENTIFICATION 1669-MW-88

SAMPLE ID. DUPLICATE ID.

STATIC WATER LEVEL (ft btoc) 16.59

WATER COLUMN (feet) 51.66m

WELL VOLUME (V) (gals) (13.7 x 0.65) = 8.6

		PURGING DEVICE	2" SUBMERSIBLE GROUNDEOS PUMP
		SAMPLING DEVICE	DISPOSABLE TEFLON BAILER
PID READING IN CASING (ppm)		(initial) <u>0.0</u>	(vented to) <u>0.0</u>
PID READING IN BREATHING ZONE (ppm)		(initial) <u>0.0</u>	(vented to) <u>0.0</u>

TOTAL WELL DEPTH (ft btoc) 29.9

CASING DIAMETER (in) 4

3 V (gals) 25.8

SAMPLER'S SIGNATURE JR CJO

Time	Activity	Water Level (ft btoc)	Pump Depth (ft btoc)	Temp (Deg. C)	EC (micros/cm)	pH	Turbidity (NTU)	Dissolved Oxygen (mg/L)	ORP (mV)	Color	Volume Purged (gals)	Well Volumes Purged	Flow Rate (GPM)
00:01	Begin Pump	—	29.5										0.5
00:06	24.06	21.61	15.76	16.42	5.58	7.44	1.85	245.2	clear	2.0	0.23		
01:11	27.40	24.06	15.85	16.44	5.59	9.35	1.57	244.5	clear	4.0	0.47		
01:13	End Pump / Well Dry	27.40	16.05	15.70	5.43	14.0	1.69	253.5	clear	6.0	0.70		
02:25	Sample 0	27.40	16.34	15.36	7.21	41.2	3.20	348.2		7.0	0.81		

Form number Tt-O-050 (6/02) Fe+2 (ppm) — Taken from first bailer, immediately before sampling.
WATER LEVEL (ft btoc) AT TIME OF SAMPLING: 29.43

Comments:

PARAMETERS FOR WATER QUALITY STABILIZATION		
Temperature ± 1 C (1.8 F)	Conductivity $\pm 5\%$	
pH ± 0.1	Turbidity 5 NTUs	

Note: All water levels and pump depths are measured from the notch in the top of the well casing. If volatiles are detected above background in the breathing zone during the initial screening, the breathing zone will be monitored during purging and sampling activities and the PID readings will be recorded in the logbook.



TETRA TECH, INC.
4213 State Street, STE 100
Santa Barbara, CA 93110
Telephone: (805) 681-3100
Fax: (805) 681-3108

GROUNDWATER MONITORING WELL FIELD DATA LOG SHEET - PURGING

Page 1 of 1

DATE 2/25/05

PROGRAM NAME B6MP

MONITORING WELL IDENTIFICATION

SAMPLE ID AREA 1-SP-1

STATIC WATER LEVEL (ft bmc)

WATER COLUMN (feet)

PUMP & TUBING (V) (L)

3 V (L)

SITE NUMBER 20 Area 1

SAMPLING DEVICE Grab Sample

PID READING IN CASING (ppm)

PID READING IN BREATHING ZONE (ppm)

SBD (feet)

SAMPLER'S SIGNATURE Brian Dorn

Time	Activity	Water Level (ft bmc)	EC (µmhos/cm)	Temp (Deg C)	pH	Turbidity (NTU)	Dissolved Oxygen (mg/L)	ORP (mV)	Color	Volume Purged (L)	Pump & Tubing Volumes Poured	Flow Rate (L/Min)
1015	Collect Sample											

Form number T-0-049 (6/02)

WATER LEVEL (ft bmc) 0' 0" — Taken immediately before sampling.

Comments: unable to measure water quality parameters 5 due to unstable terrain (active mud slide)

PARAMETERS FOR WATER QUALITY STABILIZATION		
Temperature	± 1 C (1.8 F)	Conductivity $\pm 5\%$
pH	± 0.1	Turbidity 5 NTU

APPENDIX B

CHAIN-OF-CUSTODY RECORDS

